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(54) [Title of the Invention] METHOD AND APPARATUS FOR PRDUCING IMAGES

(57) **[Abstract]**

[Problem to be solved] To accurately correct density irregularity by recording an image on a photosensitive member with print heads based on image data, and setting the image as an image recorded with an interval longer than a recording element in the recording element arrangement direction.

[Solution] Print heads 30a to 30c are driven by image having a certain gradation so as to expose an image on a photographic paper as a recording medium. Based on a patch image obtained by developing the photographic paper, an image is formed while correcting the irregularity of the exposure amount, which is a recording characteristic of light emission elements comprising the print heads 30a to 30c. That is, the image is corrected by recording the image on the photosensitive member based on the image data using the print heads 30a to 30c, and having the image after an interval longer than one recording element in the recording element arrangement direction. Thereby, the density irregularity can be corrected accurately.

[What Is Claimed Is]

[Claim 1] A method of producing images, which records an image from image data on a photosensitive material with a printing head having a plurality of recording elements arranged in a given array, measures the density of the image, determines an amendment of the recording characteristic of each of the recording element, and produces an image using the amendment, wherein the image is recorded by having at least a space equal to the recording element along the array arrangement of the recording elements.

[Claim 2] A method of producing images according to claim 1, wherein the image

is recorded by having a periodic characteristic along the array arrangement of the recording elements.

[Claim 3] A method of producing images according to claim 1 or 2, wherein the amendment is calculated after converting the density data measured at least at two different points along the array arrangement of the recording elements into an amount of exposure light.

[Claim 4] A method of producing images according to claim 3, wherein the conversion of the density data into the exposure light utilizes a characteristic curve of the photosensitive material.

[Claim 5] A method of producing images according to any of claims 1 to 4, wherein the photosensitive material is a silver halide photosensitive material.

[Claim 6] A method of producing images according to claim 5, wherein the photosensitive material has a reflective support therein.

[Claim 7] An apparatus for producing images comprising: a printing head having a plurality of recording elements arranged in an array; a printing head controlling means for controlling the action of the printing head in accordance with the image data; and a transfer means for transferring the printing head or a recording medium or both, wherein the printing head controlling means has an image producing mode for controlling the action of the printing head in accordance with the image data and an amendment mode for driving at least every but one of the recording elements along the array arrangement.

[Claim 8] An apparatus for producing images according to claim 7, wherein the image data is a periodic image which is periodic along the array arrangement of the recording elements.

[Claim 9] An apparatus for producing images according to claim 7 or 8, wherein the amendment is calculated after converting the density data measured at least at two different points along the array arrangement of the recording elements into an amount of exposure light.

[Claim 10] An apparatus for producing images according to claim 9, wherein the conversion of the density data into the exposure light utilizes a characteristic curve of the photosensitive material.

[Claim 11] An apparatus for producing images according to any of claims 7 to 10, wherein the photosensitive material is a silver halide photosensitive material.

[Claim 12] An apparatus for producing images according to claim 11, wherein the photosensitive material has a reflective support therein.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The present invention relates to a method and an

apparatus for producing images to perform image recording be recorded through correcting variations in the recording characteristic between a plurality of recording elements in an array-type printing head where the recording elements are mounted in an array.

[0002]

[Prior Art] A type of digital output apparatus for producing images of desired resolution at a higher speed has an array-type printing head, which comprises tiny light emitting elements arranged at equal intervals of a pitch, arranged for projecting through a selfoc lens array a beam spot on a photosensitive material for recording digital images. For reproducing moderate gradations of image, such as sensitive tones of the human skin or the sky, it is essential for such a digital output apparatus to have at least 200 or more gray levels in the printing. A multi-level scheme is proposed for turning on the array-type printing head several times at different irradiation levels to print gradations of 200 or more gray levels.

[0003] The array-type printing head may be selected from LED head, fluorescent vacuum tube head, PLZT printing head with a proper back light, optical-shutter array printing head such as LED shutter array type, and semiconductor laser head. The light emitting element used in the array-type printing head may generally have variations in the light irradiation. Such variations in the light irradiation between the light emitting elements in the array-type are directly translated to discrepancies in the gradations of the image. The digital output apparatus using the method of producing 200 or more gray levels may largely depend on the irradiation characteristic of the light emitter element. The light emitting elements of the printing head in the image recording apparatus are however varied in the irradiation light amount, hence producing 20 % to 40 % of error. A common photograph should be reproduced in the multi-level gradation with at least as a lower error rate as 2 %. If the photograph of quality is needed, the error rate has to be declined to 1 % or less. The error rate of smaller than 2 % or 1% can be achieved only by highly advanced measuring and calculating techniques. This is however difficult in the actual operation. For avoiding the difficulty, a known method is provided for producing a reference solid image at predetermined gradations on a sheet of photosensitive paper, measuring the levels developed on the photosensitive paper, and calculating an amended amount of the irradiation light of each light emitting element to have a desired level.

[0004]

[Problem to be Solved by the Invention] However, according to the known method for amendment, the light emitting elements in the array-type printing head are assigned to the image density measured through estimating the position of

pixels of the image density determined by dividing the length of one side of the solid image on the photosensitive paper equally by the number of the light emitting elements in a row along the scanning direction of the array-type printing head. This may develop a discrepancy between the image density measured by a gray level meter and the position of each of the light emitting elements aligned along the scanning direction in the array-type printing head. Accordingly, the amended amount of the irradiation light will hardly be accurate. This is considered to result from the following causes.

[0005] For example, the array-type printing head is commonly arranged with the light emitting elements aligned at equal intervals of substantially 85 micrometers for reproduction of 300 dpi of the resolution. In practice, in view of the actual yielding of LED array heads, more than 2500 of the light emitting elements can hardly be mounted on a single, longitudinally extended array-type printing head. It is hence common to prepare and join short LED array chips to one another to have a long LED array head. Accordingly, even if the light emitting elements on each short LED chip are aligned at equal intervals, the short LED array chips of the resultant long LED array head may hardly be joined at equal intervals. As a result, the distance between any two adjacent light emitting elements on the long LED array head will rarely be equal. Also, while the fluorescent vacuum tube printing head of a considerable length is possibly fabricated at once, it is extremely difficult to align the light emitting elements at equal intervals. Any other light emitting elements may be aligned at equal intervals only with much difficulty. As the light emitting elements are actually aligned at unequal intervals, the method of measuring the position of the light emitting elements by simply dividing the length of the head by the number of the light emitting elements will rarely be successful. Accordingly, the amended amount of the irradiation light may be erratic.

[0006] Alternatively, if for example ,the array-type printing head for reproducing a digital image at 300 dpi of the resolution has the light emitting elements of 80 micrometers long aligned along the row at intervals of 85 micrometers so that each pixel extends smaller than the interval, the position of each pixel can be measured as theoretically assigned to the peak of density data and therefore be capable of detecting. However, the focusing system of a selfoc lens in the array-type printing head is commonly designed for focusing the irradiation light at intervals of a few millimeters to ten and more millimeters on a sheet of photosensitive material. When the photosensitive material is a silver halide material which is highly deflectable during the transportation due to less rigidity of its support material as compared with a photosensitive drum used commonly in known electronic photographic processing, it may cause the beam spot to be defocused. The

defocusing will hence result in noises of the gradations in the batch image after development and interrupt the measurement of the peak assigned to the light emitting element.

[0007] Also, when the photosensitive material is a silver halide color paper which has a base layer for supporting photosensitive layers, it may create halation of the beam spot due to reflection of the light on the interface between the photosensitive layers and the base layer. This will result in blurring in the batch image after development and interrupt the measurement of the peak.

[0008] Moreover, in case that the light emitting elements greater than the pixel pitch are arranged in a zigzag form, two adjacent pixel images may overlap each other thus interrupting the measurement of the peak of the gradation data.

[0009] Because of the above drawbacks, the light emitting elements on any array-type printing head are found difficult to determine a correct amended amount of the irradiation light.

[0010] It is thus an object of the present invention, in view of the above aspects, to provide an image producing method which can accurately correct discrepancies in the gradations.

[0011]

[Means for Solving the Problem] The above object of the present invention is implemented by the following teachings.

[0012] (1) A method of producing images, which has steps of recording an image from image data on a photosensitive material with a printing head having a plurality of recording elements arranged in a given array; measuring the density of the image; determining an amendment of the recording characteristic of each the recording element; and producing an image using the amendment, is provided in which the image is recorded by having at least a space equal to the recording element along the array arrangement of the recording elements.

[0013] The method for producing images according to the paragraph (1) allows each of the light emitting elements to be controlled with an amended amount of the exposure light without receiving no undesired effects of defocusing and halation of the beam spot while the pixel location of the batch image density data and the light emitting element position of an array-type printing head match each other at higher accuracy.

[0014] (2) The method for producing images according to the paragraph (1) is modified in which the image is recorded by having a periodic characteristic along the array arrangement of the recording elements. This method can provide the simplification, the high speed operation, and the accuracy improvement of an algorithm for the peak detection for ensuring the periodic characteristic of the image.

[0015] (3) The method of producing images according to the paragraph (1) or (2) is modified in which the amendment is calculated for each recording element after converting the density data measured at least at two different points along the array arrangement of the recording elements into an amount of exposure light. This method can calculate the amount of exposure light at higher accuracy and with much ease.

[0016] (4) A method of producing images according to the paragraph (3) is modified in which the conversion of the density data into the exposure light utilizes a characteristic curve of the photosensitive material. This method can calculate the exposure light at higher accuracy and with much ease.

[0017] (5) A method of producing images according to any of the paragraphs (1) to (4) is modified in which the photosensitive material is a silver halide photosensitive material.

[0018] (6) A method of producing images according to the paragraph (5) is modified in which the photosensitive material has a reflective support therein.

[0019] Fig. 10 is a schematic view showing an array of the printing head.

[0020] It is noted that the array is not limited to a linear form such as shown in Fig. 10a but may be a zigzag form shown in Fig. 10b or a specific form shown in Fig. 10c. The recording elements are numbered as shown to identify any two adjacent recording elements by number along the array arrangement.

[0021] (7) An apparatus for producing images is provided comprising: a printing head having a plurality of recording elements arranged in an array; a printing head controlling means for controlling the action of the printing head in accordance with the image data; and a transfer means for transferring the printing head or a recording medium or both, wherein the printing head controlling means has an image producing mode for controlling the action of the printing head in accordance with the image data and an amendment mode for driving at least every but one of the recording elements along the array arrangement. This apparatus can minimize undesired artifacts of the image resulting from defocusing and diffusion, thus improving the peak detection for each recording element on the image.

[0022] (8) An apparatus for producing images according to the paragraph (7) is modified in which the image data is a periodic image which is periodic along the array arrangement of the recording elements. This apparatus can provide the simplification, the high speed operation, and the accuracy improvement of an algorithm for the peak detection for ensuring the periodic characteristic of the image.

[0023] (9) An apparatus for producing images according to the paragraph (7) or (8) is modified in which the amendment is calculated for each recording element after converting the density data measured at least at two different points along the

array arrangement of the recording elements into an amount of exposure light. This apparatus can calculate the exposure light at higher accuracy, thus increasing the accuracy of an amended amount of the exposure light.

[0024] (10) An apparatus for producing images according to the paragraph (9) is modified in which the conversion of the density data into the exposure light utilizes a characteristic curve of the photosensitive material. This apparatus can calculate the exposure light at higher accuracy and with much ease.

[0025] (11) An apparatus for producing images according to any of the paragraphs (7) to (10) is modified in which the photosensitive material is a silver halide photosensitive material.

[0026] (12) An apparatus for producing images according to the paragraph (11) is modified in which the photosensitive material has a reflective support therein.

[0027]

[Preferred Embodiments] Embodiments of an image producing method and an image producing apparatus using the method according to the present invention will be described below referring to the accompanying drawings.

[0028] The description of the image producing method is initiated prior to the image producing apparatus.

[0029] The image producing method of the present invention comprises the steps of driving three printing heads 30a to 30c, each having an array of light emitting elements as recording elements, with image data of predetermined gradations to irradiate light onto a sheet of printing paper 20 as a recording medium and correcting variations of the exposure light of the light emitting elements or recording elements in the printing heads 30a to 30c on the basis of gradation data of a batch image developed on the printing paper 20. The method of correcting the exposure light is now explained referring to Figs. 1 to 5.

[0030] Fig. 1 is a flowchart of the method of correcting the exposure light of the printing heads in this embodiment. Fig.2 is a schematic view of the batch images for correcting the exposure light. Fig. 3 is a graphic diagram showing a profile of reproduced density relative to the image data DSW of each light emitting element. Fig. 4 is a graphic diagram showing the density of sampled data. Fig. 5 is a schematic diagram showing a method of converting the density data into a light amount data.

[0031] The image producing apparatus produces on a sheet of printing paper the batch image shown in Fig. 2 for correcting the exposure light (at Step 1 shown in Fig. 1). The action of Step 1 is explained in more detail.

[0032] The light emitting elements with odd numbers from one along the direction of the row (X direction)only are illuminated with the same DSW (to print the first row

shown in Fig. 2). Then, the light emitting elements with even numbers only are turned on with the DSW (to print the second row). The light emitting elements at division by four leaving one only are turned on with the DSW (to print the third row). The light emitting elements at division by four leaving two only are turned on with the DSW (to print the fourth row). The light emitting elements at division by four leaving three only are turned on with the DSW (to print the fifth row). The light emitting elements at division by four leaving non only are turned on with the DSW (to print the sixth row). Finally, all the light emitting elements are illuminated at once with the DSW (to print the seventh row).

[0033] The DSW for each row is the same data as causing the average density to be about 1.0 at the seventh row.

[0034] The photosensitive paper 20 is conveyed to a development station where the batch image for determining an amended amount of the exposure light is developed on the photosensitive paper 20 by known developing process.

[0035] The batch image for determining an amended amount of the exposure light developed on the photosensitive paper 20 is then measured at each row using a density meter (at Step 2 shown in Fig. 1). The density meter scans an area of 5 micrometers in the X direction by 1 mm in the Y direction and measures the density successively at intervals of 5 micrometers along the X direction in each row from the end.

[0036] Fig. 4 is a graphic diagram showing a curve of the part of density measurements of a row of the batch image for determining an amended amount of the exposure light, plotted along the array direction.

[0037] More particularly, Fig. 4a illustrates in a real line the image density of the batch image for determining an amended amount of the exposure light which are produced by illuminating every but one of the pixels (light emitting elements) of a length of 80 micrometers along the array direction aligned at intervals of 85 micrometers along the same direction on an array-type printing head for reproducing 300 dpi of the resolution, representing the first and second rows of the batch image shown in Fig. 2. Fig. 4b illustrates in a real line the image density of the batch image for determining an amended amount of the exposure light which are produced by illuminating every third of the pixels (recording elements) of a length of 80 micrometers along the array direction aligned at intervals of 85 micrometers along the same direction on an array-type printing head for reproducing 300 dpi of the resolution, representing the third to sixth rows of the batch image shown in Fig. 2. Fig. 4c illustrates in a real line the image density of the batch image for determining an amended amount of the exposure light which are produced by illuminating all the light emitting elements of a length of 80

micrometers along the array direction aligned at intervals of 85 micrometers along the same direction on an array-type printing head for reproducing 300 dpi of the resolution, representing the seventh row of the batch image shown in Fig. 2.

[0038] The dotted line represents the density measurement produced by illumination of each light emitting element on the array-type printing head while the real line represents the density data measured with the density meter. The density data denoted by the real line is greater than those denoted by the dotted lines. This results from the overlapping between adjacent pixels due to halation by random reflection or the like of the exposure light on the photosensitive paper. As apparent from Figs. 4a and 4c, the density at each pixel is elevated by the overlapping. The density data shown in Fig. 4b is as described above measured by illuminating every third of the pixels as apparently not affected by the overlapping.

[0039] No peak can be detected from the density data shown in Fig. 4c which are overlapped. However, the density data shown in Figs. 4a and 4b exhibit some peaks. The peaks of the density data correspond to irradiation on the photosensitive paper from a center region of the array of the light emitting elements in the array-type printing head. Accordingly, the position of the light emitting elements in the array-type printing head can be determined from the density data sampled. As the peaks are identified, a correct level of the exposure light of each light emitting element can be calculated from the density about the corresponding peak. The method of accurately identifying the peak is now explained.

[0040] As the density data sampled extend non-linearly at low and high as shown in Fig. 5a, it can hardly be converted into an accurate level of the exposure light. For compensation, the density data is first converted into log E using the characteristic curve (Fig. 5b) of the photosensitive paper as a printing medium in this embodiment. Log E covers from a low level to a high level of the density data. This is shown in Fig. 5c. Then, the exposure light E is calculated from log E as shown in Fig. 5d (at Step 3 shown in Fig. 1). The average is determined from the calculated levels of the exposure light E, each cross point where the average and the exposure light E intersect each other is calculated (S1, S2, S3, and S4 shown in Fig. 5d), and the processing is performed for each row such that the center point (P1 or P2 shown in Fig. 5d) in each range where the exposure light between two adjacent cross points is greater than the average is then determined as the center of the light emitting element (at Step 4 shown in Fig. 1).

[0041] The exposure light at the center is then accumulated throughout a range from left to right and a sum of the exposure light is referred to as that of the light emitting element Here the exposure lights of the center and eight points throughout arrange from left to right are summed(at Step S5 shown in Fig. 1).

[0042] The average E0 of all the light emitting elements is calculated from the exposure light Ei (i being an element number) of each light emitting element. As the average E0 is referred to as a reference level, a ratio C1 between the exposure light of each light emitting element and the reference level is thus the amended amount of the exposure light of each light emitting element (at Step 6 shown in Fig. 1). Ci=E0/Ei is now established. The reference level is not limited to the average but may be any other value.

[0043] The amended amount Ci of the exposure light of each light emitting element is then saved in an exposure light amendment circuit 100. The amended amount Ci may be multiplied by the image data converted in the exposure light of each pixel at the output of image thus to generate an image where a variation in the exposure light of each light emitting element is corrected (at Step 7 shown in Fig. 1).

[0044] Above is the method of modifying the exposure light on a printing head according to this embodiment.

[0045] Data outputs from the first and second rows of the batch image shown in Fig. 2 may be used for calculating the amended amount for all the pixels. Also, data outputs from the third to sixth rows shown in Fig. 2 may be used for calculating the amended amount of all the elements.

[0046] Alternatively, while the rows of the batch image are not limited to periodic selections, such as every but one or every third, of the pixels but may be determined from any desired pattern including no two adjacent pixels, some of them can be used with equal success for the calculation.

[0047] Preferably, when the batch image is based on a periodic pattern of the pixels as shown in Fig. 2, its processing for roughly determining the position of the pixels can be simplified and thus hastened.

[0048] The DSW for the batch image are set, but not limited, to such a level that the average density in the (seventh in Fig.2) row of all the pixels is 1.0. Preferably, when the average density of DSW ranges from 0.5 to 1.5 and more preferably from 0.7 to 1.3, a linear portion of the characteristic curve of the photosensitive material may favorably be used for converting the density to the exposure light. The process of conversion will thus be simplified. Also, two or more of the rows of different DSW can be fetched and used with equal success for the calculation of the amended amount.

[0049] A digital output apparatus equipped with the array-type printing head for using a exposure light scanning method according to the present embodiment will be described referring to Figs. 6 to 9.

[0050] Fig. 6 is a block diagram schematically showing an arrangement of the image producing apparatus. Fig. 7 is a block diagram of a printing head controller

circuit.

[0051] The printing head is substantially arranged with a plurality of recording elements aligned at equal intervals in a row or rows for reproducing a desired level of resolution and may be selected from LED head, fluorescent vacuum tube head, PLZT printing head with a proper back light, optical shutter head such as liquid crystal shutter array printing head, semiconductor laser head, and thermal head. Preferably employed are an apparatus for recording images on a silver halide photosensitive material with the use of an array of recording elements, an apparatus for recording images in volatile ink with the use of a thermal head, and an apparatus for producing images of different gradations. Two or more of the printing heads as described above may be combined and used as the printing heads 30a to 30c. In case that a combination of the liquid crystal shutter and the light emitters is used, they may preferably be assembled in a two-dimensional arrangement rather than the array arrangement especially for fastening the recording action and increasing the size of images. Also, the two-dimensional arrangement can control the speed of image output to a moderate rate even if the recording time of each element is increased. Accordingly, discontinuity in the gradations resulting from repeat of the recording action of given pixels may be minimized and preferable gradations can be obtained. When a high-speed switching means such as LED head, VFPH head, and highly dielectric LCD shutter head can also minimize the discontinuity in the gradations resulting from repeat of the recording action of given pixels and preferable gradations can be obtained. This embodiment can be emphasized in the advantageous effect when the recording medium is a soft gradations material such as silver halide photosensitive material. As the advantage of controlling the duration of illumination permits reproduction of smaller stepped gradations, a resultant image will be smooth and highly pictorial.

[0052] For ease of the description, the embodiment employs the printing heads 30a to 30c of LED type and VFPH type.

[0053] The image producing apparatus has a support drum 1 rotated by a driver not shown for conveying a sheet of color photographic printing paper 20 (referred to only as printing paper hereinafter) from a roll in the direction of the white arrow. The printing paper 20 is then exposed to exposure light of an image data from the red-color printing head 30a, the green-color printing head 30b, and the blue-color printing head 30c controlled by corresponding driver circuits 200. As the printing paper 20 is exposed to different color lights at the specified position in a sequence, a color latent image is developed on the printing paper 20 which is then conveyed over the support drum 1 to a development apparatus.

[0054] The image data is supplied via an I/F 1 from a personal computer. The

image data received at the I/F 1 is then divided by a RGB splitter 3 into red, green, and blue components. The red component is saved in a DRAM 4, the green component is saved in a DRAM 5, and the blue component is saved in a DRAM 6. The DRAMs 4, 5, and 6 are accessed by a CPU 2 retrieving the image components for their corresponding printing heads. Then, the image components are transferred to exposure light amendment circuits 100 and then the diver circuits 200.

[0055] Each of the printing heads 30a to 30c has one or more rows of light emitting elements. The red-color printing head 30a of LED type is arranged in which the center wavelength of light is 660 nm, the resolution is 300 dpi, and the number of LEDs is 5120. The LED may be of GaAlAs or GaAsP type which is high in the efficiency of illumination and preferably a type having a peak wavelength of 650 to 680 nm for selectively sensitizing at a higher efficiency the red-color photosensitive layer in the silver halide color photosensitive material. Also, the LED can quickly be turned on and off on the order of nanoseconds as suited for controlling the illumination time at higher accuracy.

[0056] The green-color printing head 30b and the blue-color printing head 30c are of vacuum fluorescent printing head (referred to as VFPH hereinafter) for allowing color separation at relatively high luminance and speed of response with the use of color filters. As the VFPH employs a single fluorescent material for producing a wider spectrum range of illumination from blue to green, it can selectively sensitize the blue and green photosensitive layers in the silver halide color photosensitive material in combination with the color filters. Also, the efficiency of illumination is relatively high and a change in the temperature during the illumination is small. Accordingly, the transition of peak caused by a change in the temperature will be minimized and the silver halide photosensitive material which is highly selective of the wavelength will remain stable in the exposure efficiency.

[0057] The green-color printing head 30b may have a positional error equivalent to the distance between two adjacent printing heads along the conveying direction (denoted by the arrow shown in Fig. 7) of the color printing paper 20 and a positional error along the array arrangement. Those errors can be corrected by the action of the CPU 2. The red-color printing head 30a and the blue-color printing head 30c are also controlled by the CPU 2 for correcting their positional errors. The outputs of the three heads 30a to 30c can be timed with a system clock signal. The timing signal is generated by frequency division according to the conveying speed.

[0058] The printing paper 20 is not limited to a roll but may be a series of cut pieces. The means for conveying the printing paper 20 may be a belt conveying means or any other means. While the printing paper is kept stationary at the printing, the printing heads may be driven. Alternatively, both may be driven. The

conveying direction and the array arrangement may extend at an angle to each other. The photosensitive material is not limited to the color photographic photosensitive printing paper 20 but may be any type of silver halide photosensitive material. The printing heads may be of any type which matches the sensitivity to colors of the photosensitive material. In color mode, the printing head may be of three color control type responsive to a single light source.

[0059] The exposure light amendment circuits 100 are provided for amending variations of the illumination of the light emitting elements in the array-type printing head and holds the amended amounts which are determined by the above described manner and received. More specifically, the exposure light amendment circuit 100 converts the image data received from the corresponding DRAM into the exposure light and then multiplies the amended amount of the light emitting element by the exposure light of each image data to have an amendment of the image data which is then transferred to a data output 210.

[0060] Fig. 8 is a block diagram showing a primary part of the driver circuit.

[0061] The image data released from the exposure light amendment circuit 100 is received by the driver circuit 200 which has a register for one line. The driver circuit 200 drives the printing head 30a to initiate the illumination. The driver circuit 200 comprises, as shown in Fig. 8, a data output 210, an illumination controller 220, a shift register 230, a latch 240, and a gate 250.

[0062] The data output 210 is initialized with an initial setting of count for counting the pixels of each line and writes in a line memory (not shown) 12 bits by 1 line of the image data determined by the count. As the image data of the first line has been written in the line memory by the data output 210, its bits are transferred in a sequence from MSB to LSB to the shift register 230. The data output 210 then writes the second line of the image data in the line memory. While the image data of the present line is being transferred to the shift register 230, the image data of the succeeding line is saved in the line memory. Accordingly, each line of the image data can continuously be transferred without any delay of time.

[0063] The illumination controller 220 controls the timing of an enable signal to determine the irradiating characteristic of each printing head. More specifically, when a 12-bit digital form of the image data is received in each color, it is converted into a serial pixel data of one line for the light emitting element. Simultaneously, the a set pulse signal for transferring an image bit data to the latch 240 and the enable signal for controlling the timing of illumination are produced and supplied to the corresponding printing head 30. The image bit data is a specific bit data in the image data.

[0064] The illumination controller 220 comprises a CPU and a gate circuit

including an enable signal/set pulse signal generator circuit (not shown) and a counter (not shown). Upon receiving a count-up signal produced by counting the duration of transferring the image bit data, the set pulse signal generator circuit generates the set pulse signal timed with the completion of transferring the image data to the printing head 30a and transmits it to the printing head 30a and to the enable signal generator circuit.

[0065] Also, the illumination controller 220 counts the enable time corresponding to the exposure light assigned in advance to each bit of 12 bits and transfers a count signal to the enable signal generator circuit. At the timing of the set pulse signal, the enable signal generator circuit generates an enable signal having the enable time corresponding to MSB (most significant bit) of 12 bits which indicates the exposure light from the MSB and transmits it to the printing head 30a. The CPU 2 then controls the action of the counter for generating the next set pulse signal. As the above steps are repeated the set pulse signal , the enable signal and the image bit data of each line can be timed and transferred in a sequence from MSB to LSB to the printing head 30a.

[0066] As the data output 210 transfers MSB in one line of the image bit data to the shift register 230, the illumination controller 220 supplies the latch 240 with the set pulse signal. In synchronization with the set pulse signal, the latch 240 latches MSB in one line of the image bit data. Upon receiving the enable signal of gradations from the illumination controller 220, the driver circuit 200 drives the corresponding light emitting element of one or more rows in the array to emit an illumination of the latch image data for a period determined by the enable signal. More specifically, the driver circuit 200 selectively transmits a drive signal to the light emitting element in the printing head 30a assigned to the latch data of "1" for illumination for a period determined by the enable signal. The illumination is focused by the selfoc lens array 35 on the printing paper 20 to develop a latent image. As all the bits from MSB to LSB (least significant bit) are processed in this manner, one line of the image data is recorded. The bits may be started from LSB or processed in any particular order. While the description has been made over one color, the other colors can also be recorded by the same steps.

[0067] The VFPH having the illumination characteristics over the green or blue component is equipped with a green or blue color filter, not shown, mounted beneath the selfoc lens array 35. The three driver circuits 200 of the printing heads 30a to 30c are controlled not once but in a sequence with a delay of the timing for overlapping three colors of the image data received at the corresponding printing location on the printing paper 20 thus to develop a color image of quality. The green light source may be accompanied with a yellow color filter instead of the

green color filter. The driver circuit 200 drives the printing head 30a to print 50 % or more of one line of the image data on the printing paper 20 which travels with the support drum 1 so that the image is continuous between any two lines. Accordingly, the generation of variations in the gradations will be inhibited and a resultant printed image will exhibit smooth, continuous gradations.

[0068] Fig. 9 is a timing chart showing the action of the driver circuit.

[0069] Denoted by CLOCK is a clock signal for transferring the image data. A signal DATA represents a gradation of 12 bits in one pixel which is transferred from the data output 210 to the shift register 230 in synchronization with the rise of the CLOCK signal. A signal /LOAD determines the timing of the set pulse signal. The set pulse signal is received by the latch 240 at the timing of transferring the bits to the shift register 230. This signal determining the timing of illumination is transferred from the illumination controller 220 to the gate 250. A signal STB determines the timing of the enable signal. The enable signal is released at the timing of transferring bits to the shift register 230. While the signal is turned on, the illumination continues. The duration of the illumination can be controlled as the multiplication of 1/fclock by DSW which is set to a desired value.

[0070] When the image data to be printed has multiple levels, its one pixel is divided by bit and projected a few times. For example, if the output level of eight bits is desired, the DATA signal is transferred in a sequence from the uppermost bit to the shift register 230. Also, DSWn (n being the number of illumination times required for printing one pixel) is received from the ROM. The DATA signal is then printed from the lowermost bit.

[0071] When all the latch data or bits corresponding to the enable signal from MSB to LSB for one light emitting element are "1"s, the duration of the illumination is maximum generating a maximum density. The interval between any two enable signals is 48 microseconds. The same steps are carried out for the other printing heads 30b and 30c.

[0072]

[Effects of the Invention] According to the teaching of claim 1, the present invention allows each of the light emitting elements to be controlled with an amended amount of the exposure light without receiving no undesired effects of defocusing and halation of the beam spot while the pixel location of the batch image density data and the light emitting element position of an array-type printing head match each other at higher accuracy, hence diminishing variations in the gradations.

[0073] According to the teaching of claim 7, the present invention can minimize undesired artifacts of the image resulting from defocusing and diffusion, thus improving the peak detection for each light emitting element on the image.

[0074] According to the teaching of claims 2 and 8, the present invention can provide the simplification, the high speed operation, and the accuracy improvement of an algorithm for the peak detection for ensuring the periodic characteristic of the image.

[0075] According to the teaching of claims 3 and 9, the present invention can calculate the exposure light at higher accuracy, thus increasing the accuracy of an amended amount of the exposure light.

[0076] According to the teaching of claims 4 and 10, the present invention can calculate the exposure light at higher accuracy and with much ease.

[0077] According to the teaching of claims 5 and 11, the present invention can improve its effectiveness.

[0078] According to the teaching of claims 6 and 12, the present invention can more improve its effectiveness.

[Brief Description of Drawings]

[Fig. 1] A flowchart of a method of amending the exposure light of a printing head according to one aspect of the present invention.

[Fig. 2] A schematic view of a batch image produced for amending the exposure light.

[Fig. 3] A graphic diagram showing the density reproduced from DSW of one light emitting element.

[Fig. 4] A graphic diagram showing sampled measurements of the density.

[Fig. 5] A schematic diagram of method of detecting the pixel position from the density data.

[Fig. 6] A block diagram schematically showing one example of an image producing apparatus.

[Fig. 7] A block diagram of printing head controller circuit.

[Fig. 8] A block diagram showing primary components in a driver circuit.

[Fig. 9] A timing chart showing an action of the driver circuit

[Fig. 10] A schematic diagram showing an array of the printed head.

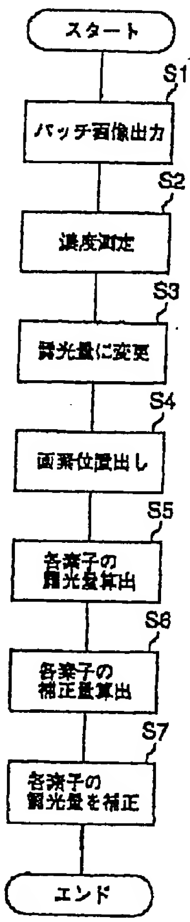
[Explanation of Reference Numeral]

2	CPU
3	R, G, B Splitter
4, 5, 6	DRAM
30a – 30c	Printing Heads
100	Exposure Light Amendment Circuit
200	Driver Circuit
210	Data Output
230	Shift Register

240	Latch
250	Gate

[Fig 1]

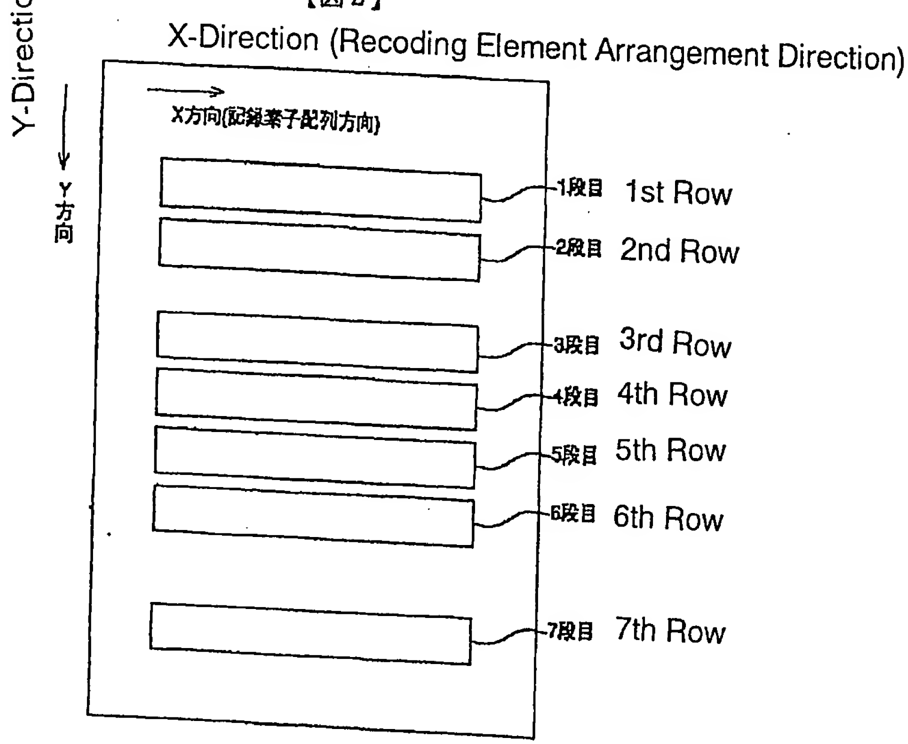
【図1】



Start
S1: Output Batch Image
S2: Measure Density
S3: Convert Density Data into Exposure Amount
S4: Determine Position of pixel
S5: Calculate Exposure Light Amount for Each Pixel
S6: Calculate Amended Amount for Each Pixel
S7: Amend Exposure Light Amount for Each Pixel
End

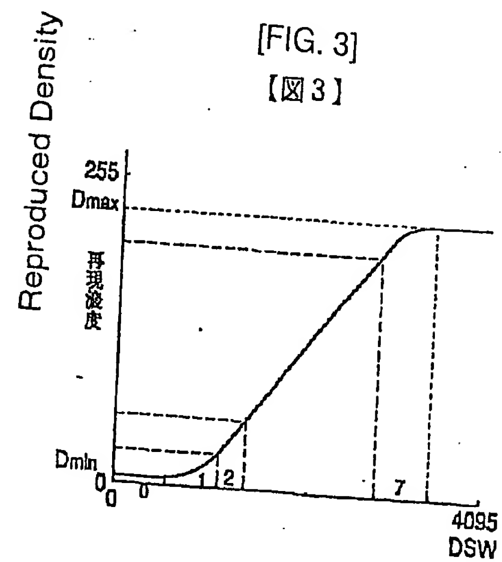
[Fig. 2]

【図2】

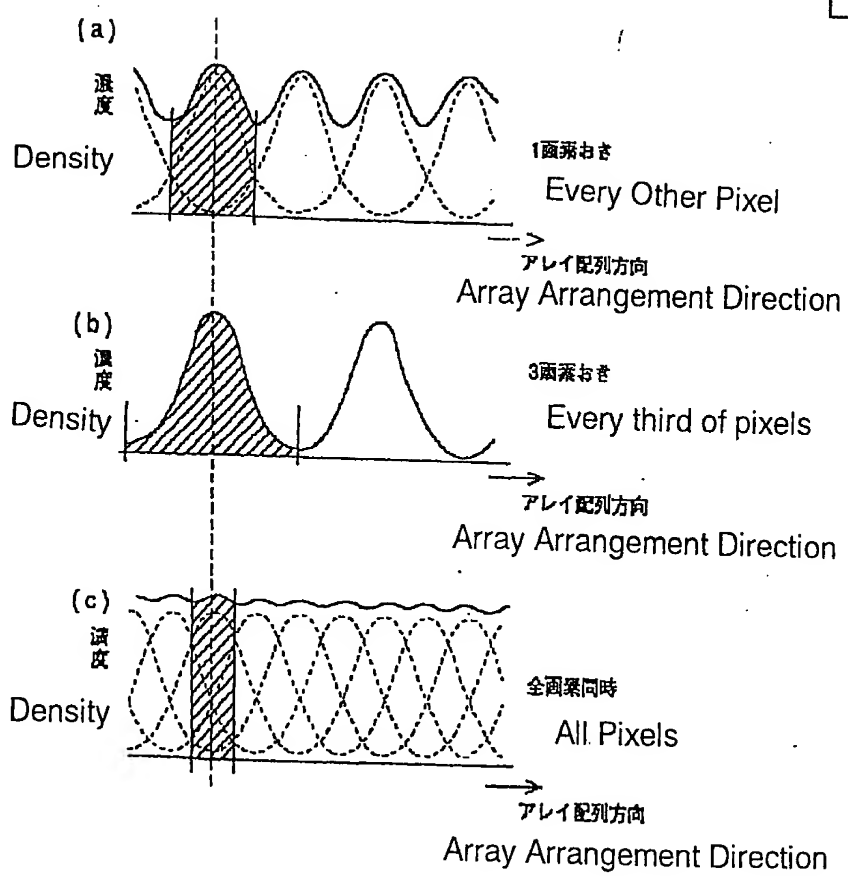


[FIG. 3]

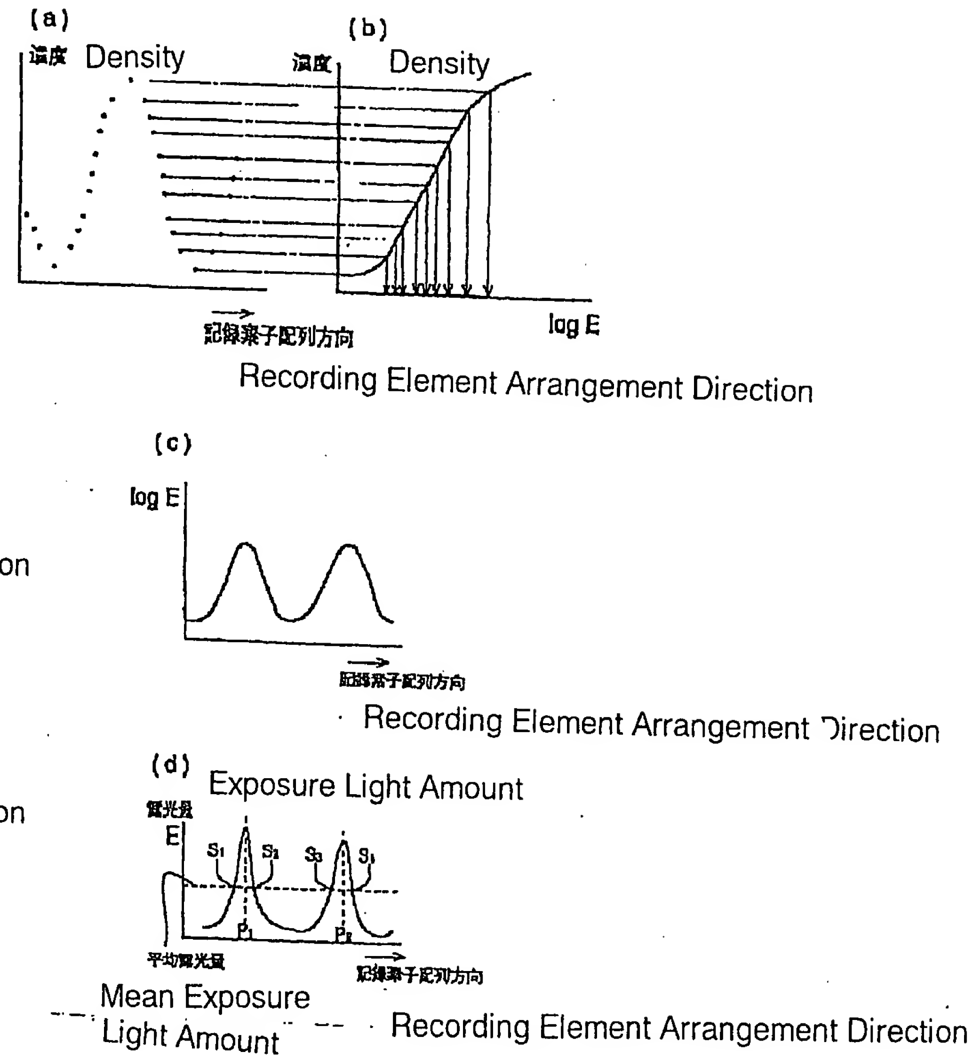
【図3】



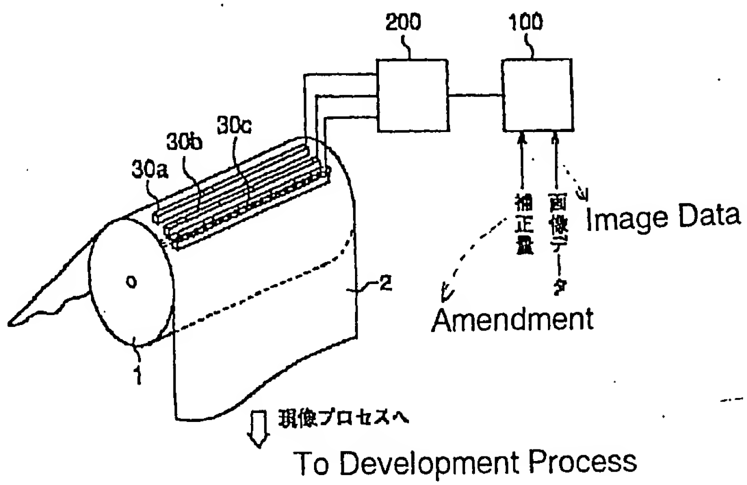
[Fig. 4]
【図4】



[Fig. 5]
【図5】

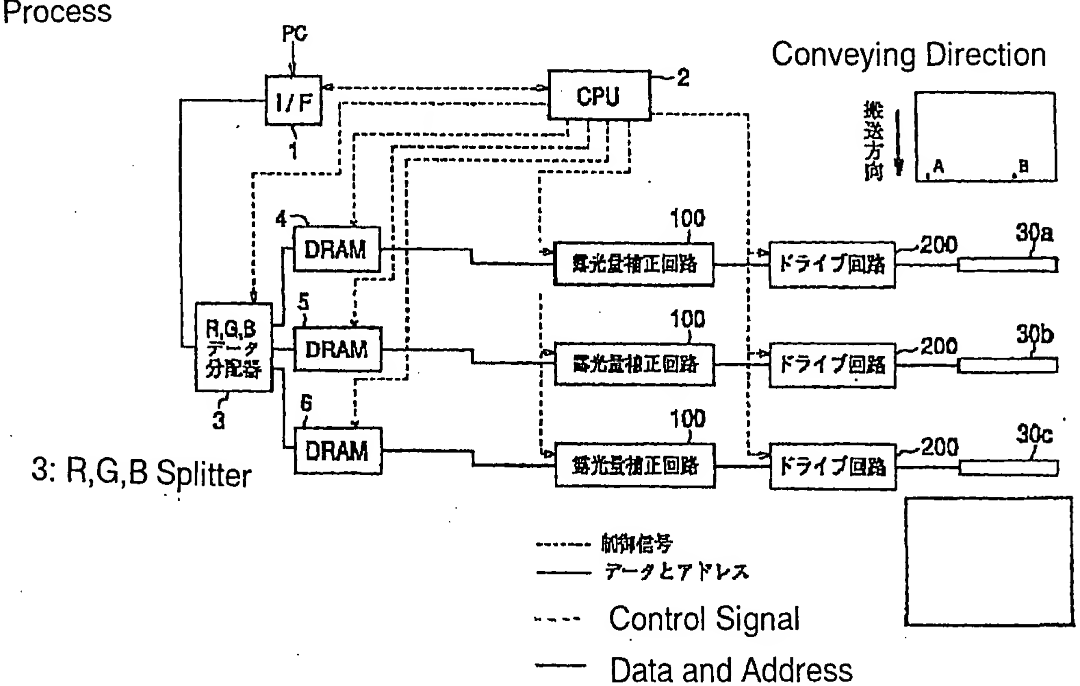


[Fig. 6]
【図６】

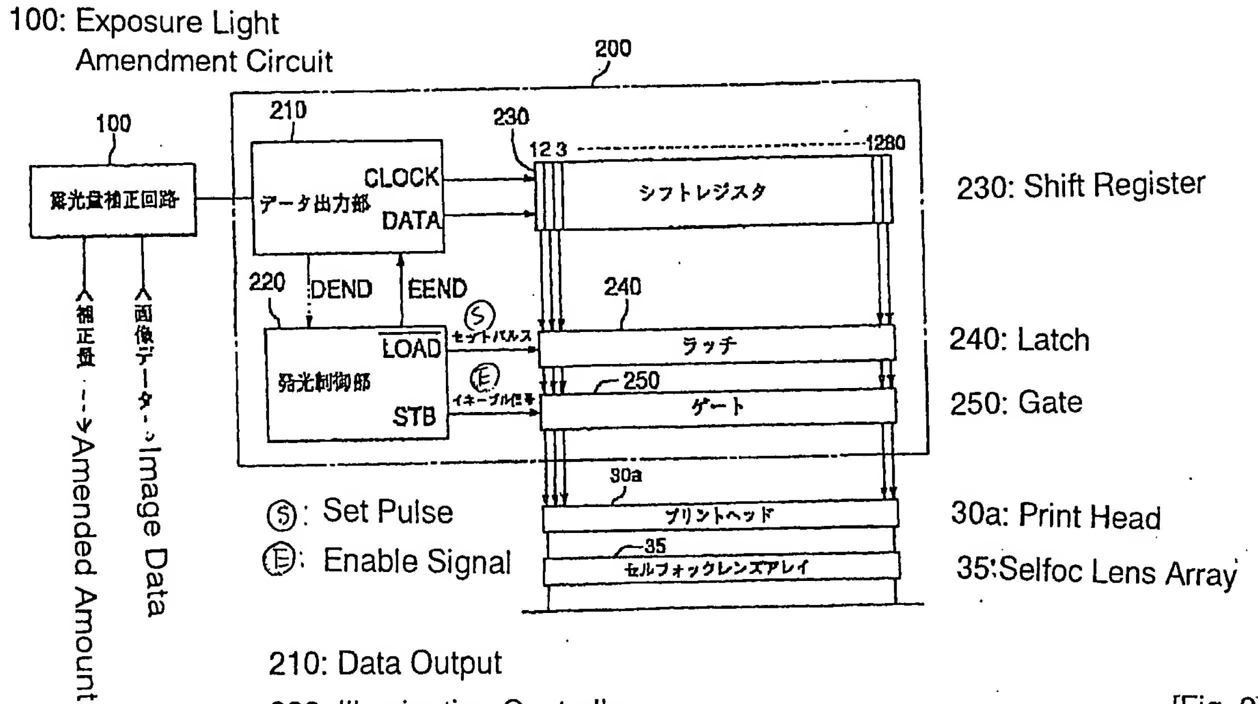


100: Exposure Light Amendment Circuit
200: Driver Circuit

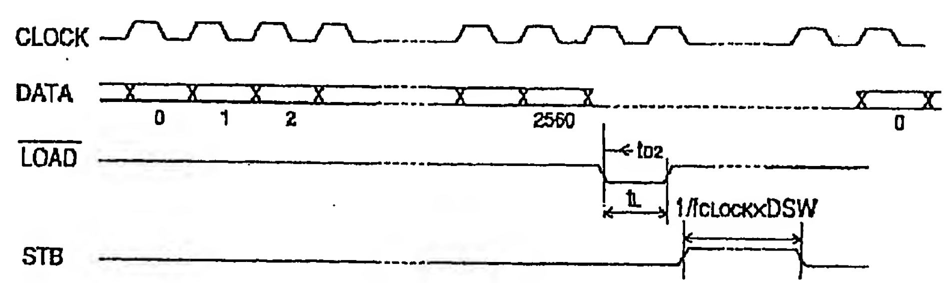
[Fig. 7]
【図７】



[Fig. 8]
【図8】

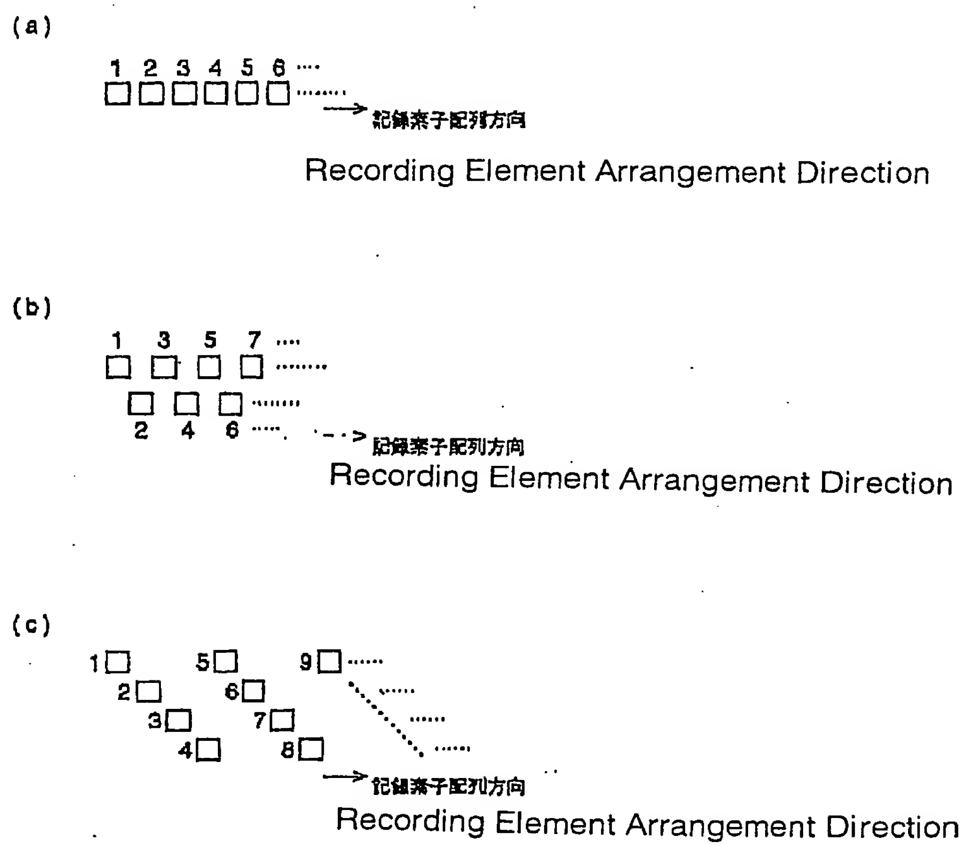


[Fig. 9]
【図9】



[Fig. 10]

【図１０】


(a)
1 2 3 4 5 6 ....
記録素子配列方向
Recording Element Arrangement Direction
(b)
1 3 5 7 ....
2 4 6 ....
記録素子配列方向
Recording Element Arrangement Direction
(c)
1 5 9
2 6
3 7
4 8
記録素子配列方向
Recording Element Arrangement Direction